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ILLINOIS-MISSOURI MINERAL RESOURCE COMPLEX — A BASE FOR INDUSTRIAL DEVELOPMENT

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ABSTRACT

Three basic factors—man, materials, and energy—are essential to the modern industrial economy. The latter two, materials and energy, are available to man primarily in the form of mineral substances.

Illinois and Missouri possess jointly a combination of mineral resources matched by few, if any, areas of equal size throughout the United States. Within the contiguous portions of these two states lie the iron ore, coking coal, limestone, and fluorspar that are requisite to the production of iron and steel—the very backbone of modern industry. Here, too, are vast reserves of mineral fuels to provide the heat and power required for industrialization. There are deposits of sand and gravel, and of stone, for construction. Limestone and shale for cement-making and shale and clays for the manufacture of refractory goods and other ceramic products are abundant. Deposits of silica sand and other siliceous materials used in the manufacture of glass, abrasives, and ceramic goods are present. In addition to all of these, important reserves of lead and zinc and deposits of various other metallic and nonmetallic minerals, including copper, cobalt, and barium, also occur.

Large-scale facilities for low-cost transportation and interchange by rail, water, and highway combine to move materials efficiently and cheaply for assembly, fabrication, processing, and distribution. Well developed and still expanding networks of electric-power and fuel-distribution lines blanket the area.

In addition to material resources and well developed facilities, the area also possesses a population made up of intelligent and well trained people. This combination of essential factors can provide a sound basis for significant growth and development.

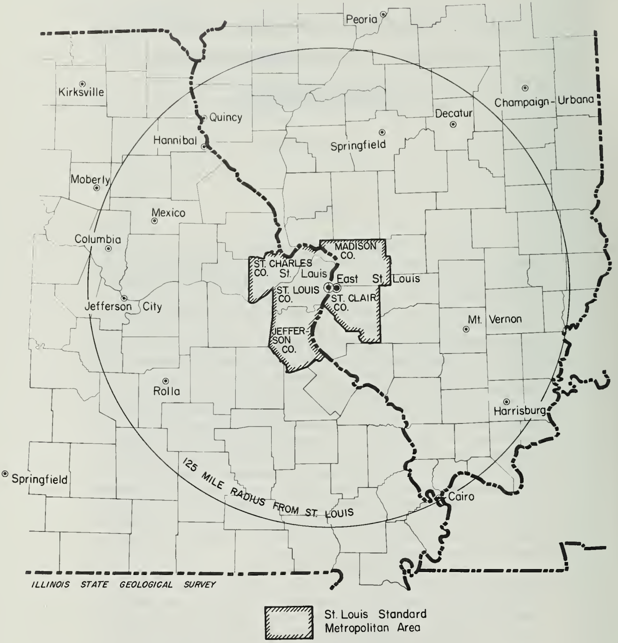


Fig. 1 - Mutually-supporting resource areas of Illinois and Missouri

PART I. GENERAL

Introduction

This publication describes the complex of mineral resources occurring in the contiguous portions of Illinois and Missouri and discusses their contribution and importance to the area. The manner in which various mineral substances supplement and complement each other in providing materials for industry is examined. The interdependency of the various segments of industry and the vital role of transportation and electric power are discussed.

The material contained in this publication was presented first as a lecture before the St. Louis Section of the American Institute of Mining, Metallurgical and Petroleum Engineers on January 12, 1962. It results from a compilation of data from many sources. The assistance of numerous persons connected with mining, transportation, power, and industrial development activities is gratefully acknowledged. Special acknowledgement is made to Dr. Thomas R. Beveridge, Director of the Missouri Division of Geological Survey and Water Resources, and members of his staff for their assistance with the maps and data pertaining to Missouri, and to the author's colleagues at the Illinois State Geological Survey.

An attempt has been made to bring the data as up to date as possible (as of January, 1962). The author accepts all responsibility for any shortcomings or inaccuracies that may occur and for the economic interpretation of the factors discussed.

Within the text, reference is made to specific publications providing information on the various minerals of the area. For readers interested in more complete information on a specific item, a supplemental list of publications, by subject or commodity, follows the references.

Scope

The area covered by this report is shown in figure 1. A major portion of the area lies within a radius of 125 miles from Greater St. Louis. This radius extends roughly half way to the surrounding cities of Chicago, Indianapolis, Memphis, and Kansas City. The Standard Metropolitan Area of St. Louis, lying within a vast region containing no other cities of major size, provides a logical focal point for study. This Standard Metropolitan Area, as designated by the United States Bureau of the Census, consists of the following (fig. 1):

East St. Louis, Illinois
Madison County, Illinois
St. Clair County, Illinois
St. Louis, Missouri
Jefferson County, Missouri
St. Charles County, Missouri
St. Louis County, Missouri

According to the 1960 Census of Population, 4.4 million people live within a radius of 125 miles of St. Louis. (This compares with 3.9 million in 1950.) Of these, 2.1 million, or about 48 percent, live within the Standard Metropolitan Area.

The large population within the region constitutes a prime reservoir both of contributors to industrial production and of consumers of industrial output. Mere

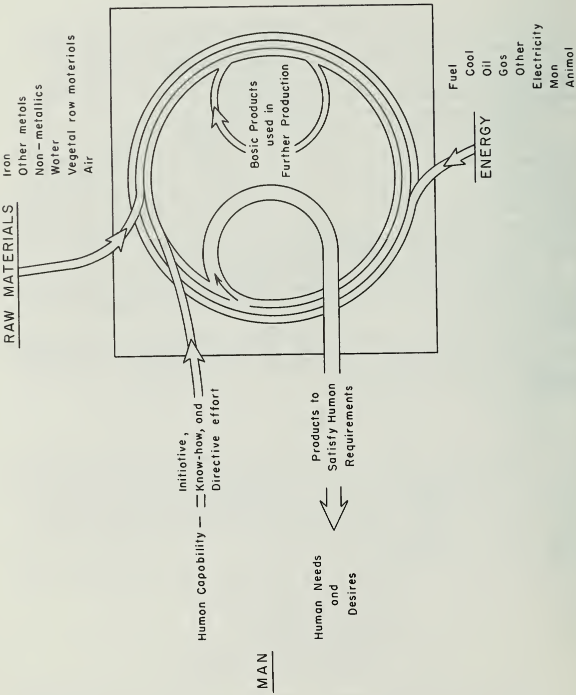


Fig. 2 - The Keys to Industrial Production

numbers of individuals, however, provide no assurance of industrial development. Without the required organizational ability, the know-how and the effort—physical and mental—of skilled and well-trained people, the modern industrial system cannot exist. Within the particular region covered by this study, the population possesses a high degree of education, industrial training, and experience. Besides basic educational facilities, no less than 20 institutions of higher learning, including junior colleges, colleges, and universities, operate within the area.

The Keys to Industrial Production

Man, materials, and energy are the keys to industrial production. Modern industry exists to provide man with the goods and products required for his well-being, comfort, and material standard of living. Through application of human capabilities, man combines and shapes forces of nature and materials into items suitable for his use. Without needs to satisfy and human requirements to meet, there would be no industrial activity; without the requisite human organizational ability, knowledge, and initiative, the modern industrial complex could not exist. As both the initiator and the beneficiary of industry, man is the indispensable ingredient.

Figure 2 shows in simplified form the flow of the essential ingredients into industrial production, and the flow of products from the system to the consumer. Although, to some degree, portions of one of the factors may be substituted for another, all three must be present. Not apparent from the diagram is the vital role transportation plays in the system by assembling the factors and distributing the output. Nor is the role of communications which brings together those possessing the factors, those controlling the production, and those who consume the output shown.

Regardless of how skilled man might be, he can accomplish little without tools and machines with which to work and without materials with which to build.

Furthermore, lacking outside sources of energy and power to supplement his own physical strength, almost the entire effort of man must be expended in producing the bare essentials of life.

The transition from raw material to finished product is not accomplished in a single sweep but occurs in a series of steps or stages, with the product of one stage combining with other items to form the input for the next stage. For this reason, the flow pattern assumes such major significance that rarely does a major industrial plant exist in isolation from other related activities. For example, a steel plant forms a nucleus for all the industries that support and supply it and for those industries that use steel in the fabrication or manufacture of other items.

Within the industrial system part of the output must be diverted from the flow of consumer goods to provide capital goods such as either new or replacement plants and equipment.

Vegetal, or plant materials, and animals provide the food that sustain human life, and in some degree they contribute raw materials to industrial production. However, it is minerals that provide the greatest portion by far of the materials and energy that modern man uses in building or manufacturing the things that maintain his high standard of living. The average quantities of major mineral products consumed directly or indirectly within the United States in 1960 is shown in table 1.

Rarely, if ever, is a material used singly or directly. Almost invariably, a useful item either consists of two or more materials (for example, a simple pocket knife with steel blades, brass casing, nickel-plated ends, and plastic handle) or is shaped or modified through the use of other materials. The material requirements of modern industry are so broad and varied that no single region or even nation is completely self-sufficient and capable of providing them all. Illinois and Missouri, however, possess a rare combination of basic mineral materials that is matched by few other areas of the country.

PART II. THE ROLE OF MAJOR MINERAL MATERIALS

Only the minerals produced in the Illinois-Missouri region are discussed here. Consumption figures presented in the tables are for the entire United States.

Iron and Steel as the Basic Metals of Modern Industry

Of all the mineral materials that man obtains from the earth and molds to his use, iron and steel are by far the most important. Comparison of the quantities of steel and other metals consumed each year, as shown in table 1, illustrates in a striking manner the preeminence of steel in modern life.

Because of iron's strength, durability, and permanence, its abundance in nature, ease of conversion from raw ore to finished product, and its relatively low cost, no other material ever has been found that could supplant it. Nor is any suitable substitute likely to be found for all its uses in the foreseeable future.

Important among the qualities of iron and steel is their ability to be cast, rolled, or drawn into desired shapes. Steels can be annealed, machined to specifications, and then retempered for use. Another of iron's characteristics of extreme importance is its alloyability. Through the addition of certain alloying agents (chromium, manganese, molybdenum, etc.) special properties of corrosion resistance, hardness, toughness, and strength can be imparted. Also significant is iron's ability to be readily magnetized and demagnetized for electrical applications.

Approximately 70 million tons of pig iron and 100 million tons of steel are manufactured within the United States each year, involving the use of 190 million tons of raw mineral materials and about 50 million tons of scrap. In 1960, an average of 3,150 pounds of iron ore, 1,500 pounds of coke, and 480 pounds of fluxing stone, plus smaller amounts of other minerals, was used for every ton of pig iron produced.

There are few activities within the modern industrial nation in which iron and steel do not play an important part through at least some of their many uses. The broad usage of steel and its application to many facets of modern life are indicated in table 2.

From the table it may be seen that 24 percent of the steel shipments go into transportation (automotive and rail) use. Construction activity consumes 13.6 percent of the shipments and machinery and equipment of various types (industrial, electrical, commercial, and domestic) account for another 11.3 percent. Containers, including cans, drums, barrels, and the like, consume 9 percent.

Thus, 57.9 percent of the steel shipments enter four major groupings of use. These uses, however, cover a multitude of products. The remaining steel shipments go into a wide array of uses either directly or through warehouses from which they are obtained for various purposes.

The actual contribution of iron and steel to industrial activity is impossible to measure. Automobiles and automotive items provide an example. One-fifth of the steel industry is engaged in producing steel used in automobiles. Another large segment of industry is engaged in the conversion of this steel into the finished product. The transportation capacity afforded by these automobiles provides the means of movement for workers, materials, and products involved in still further industrial activity. The influence provided by the availability of adequate quantities of steel for automobiles and other uses goes on and on, both directly and indirectly, throughout the economy.

Basic Construction Materials

Machines and equipment alone do not constitute the modern industrial picture. Shelter, buildings, factories, and plants must be provided. Housing must be provided, too, for the workmen who operate and maintain the plants. Transportation facilities such as railroads, airports, roads, pavements, and bridges must be provided. The construction of all these things requires vast quantities of materials that, common though they may be, are highly essential. Although steel and other metals are used to some extent in construction, millions of tons of materials such as stone, sand and gravel, cement, lime, brick, and tile must be available.

Stone

From a tonnage standpoint, stone is the most significant single mineral commodity in the United States today. More than 450 million tons of crushed and broken limestone and dolomite were consumed in 1960, as shown in table 3.

The greatest portion of the limestone and dolomite produced was crushed and used as concrete aggregate in the construction of buildings, highways, and other structures. Concrete, roadstone, and cement accounted for more than 77 percent of the total crushed stone consumed during that year. Another three percent was used as riprap and ballast, making a total of 80 percent consumed directly in construction. The remaining crushed stone was used for agriculture and for a multitude of industrial and chemical purposes. Lamar (1961) has described more than 70 uses for limestone and dolomite.

Sand and Gravel

Sand and gravel, like stone, have many uses; the most important use is as construction materials. The United States Bureau of Mines classifies sand into two categories, common sand and industrial sand. Common sand, along with gravel, is used almost entirely for construction purposes. Industrial sand, on the other hand, is applied to a wide variety of uses. The consumption of common sand, gravel, and industrial sand is shown in table 4.

About 50 percent of the common sand and almost 25 percent of the gravel are used in the construction of buildings. Another 40 percent of the sand and 65 percent of the gravel go into the paving of streets and highways.

The construction of buildings and other structures accounts for about half of the one-fourth billion tons of common sand used each year. Another 40 percent goes into the construction of streets and highways, with the remaining 10 percent used for other purposes.

Paving of streets and highways is the major use for gravel, accounting for about 68 percent of the total quantity consumed. Another 25 percent is used in building construction, and the remaining 13 percent is used for fill, railroad ballast, and miscellaneous purposes.

Industrial sand, most of which is silica sand, is used in many industrial applications, as shown in table 3. For some applications the full grained sand is used. In others the sand is ground to finer sized particles before use.

Approximately one-third of the sand consumed industrially is used in the manufacture of glass, where a high-purity silica sand is required. Molding sand, for use by the metal industries, also accounts for about one-third of the total consumption. The remaining industrial sand is used as an abrasive material, filtration medium, filler, and for numerous other purposes.

Clay

The many types of products manufactured from clay are shown in table 5.

Construction materials including heavy clay products, floor and wall tile, terra cotta, lightweight aggregate, and cement accounted for 78.6 percent of the tonnage consumed in 1960. The greater portion of this was used in heavy products such as brick, drain tile, sewer pipe, and the like, with cement-making as the second most important use.

Extremely important from an industrial standpoint is the use of clay in refractories. The iron and steel and other metals industries are highly dependent upon firebrick and other refractories as materials for furnace linings. The ability of these materials to withstand extremely high temperatures is of critical importance to the metallurgical processes. About 13 percent of total clay consumption is in refractory products.

The remaining 8.4 percent of the clay production serves numerous uses, in the manufacture of pottery and stoneware, as filler, and for general industrial purposes.

Lead and Zinc

Lead

Lead has many uses, both in metallic form and in chemical compounds, as shown in table 6.

The principal single use for lead is in storage batteries which account for about 25 percent of total consumption. Most important among other uses for metallic lead are calking lead (6.6%), cable covering (6%), and solder (6%). Lead in metal form for all uses constitutes about 72 percent of total consumption.

Among lead chemicals tetraethyl lead is very significant. This chemical, used as an anti-knock agent in motor fuel, consumes more than 16 percent of the total.

Another major use of lead is in the manufacture of various pigments for paints. This use consumes about 10 percent of the total.

Zinc

Table 7 shows the uses of zinc.

The galvanizing of steel sheet, wire, pipe, and other products to provide a protective rust-resistant coating accounts for more than 42 percent of the total consumption. Zinc base alloys, used primarily for die castings, consume another 38 percent. This means that more than 80 percent of the product is consumed in two principal uses.

Rolled zinc, zinc oxide, batteries, and other miscellaneous uses account for the remainder.

Fluorspar

Fluorspar is a mineral of many industrial uses (Finger et al., 1960), as shown in table 8.

Almost 58 percent of the fluorspar consumed in the United States is used in the manufacture of hydrofluoric acid. This acid, in turn, is used in the production of fluorine chemical compounds for insecticides, wood preservatives welding fluxes, antiseptics, tooth decay preventives, and many other purposes. Important also is the use of hydrofluoric acid in the manufacture of aluminum fluoride and synthetic cryolite, essential to the production of aluminum.

Use of fluorspar as a flux in steel-making, which in 1940 accounted for about 70 percent of consumption, currently amounts to about 33 percent.

The remaining fluorspar (table 8) is used for a variety of purposes.

Water

In recent years there has been a growing appreciation of the central role that water plays in the industrial development of a nation. Lack of adequate water supplies may very well become the factor that will limit the extent to which development can progress in many parts of the country. Water must be available not only for the industrial processes involved but also for the culinary, sanitary, and other purposes of the population supporting the industry.

Water, whether for industrial or other use, may be classified by source as surface water obtained from streams, lakes, and reservoirs and ground water obtained through wells.

The withdrawal of water from underground sources faster than the rate at which these sources are recharged is equivalent to the "mining" of this resource. No permanent industrialization can be based on such a practice. Sound development requires that sufficient water be available not only initially but throughout the full life of the operations as well.

Energy, Fuels, and Electric Power

Energy's Contribution

Much of the material progress of mankind in recent centuries has been

directly related to his increased use of the inanimate sources of energy and power which give him strength and capacities far beyond those possessed within himself. Man has sought energy from new sources, learned to release that energy, and then to harness and to direct it to his purpose. His control over inanimate energy has enabled him to shift the heavy burden of labor to tireless machines. Tasks formerly too heavy or too great for men to attempt now can be accomplished easily. Operations formerly too minute and delicate for human hands can be performed readily by powered tools or instruments.

Man has learned to convert the stored up energy of fuels into other forms and transmit it to points many miles distant from the original source of generation. He has learned to direct and concentrate energy to a small target as, for example, in the arc of a welding machine or at the point of a dentist's drill.

Through his control of energy man has been transformed from a creature of relatively limited physical capacity to a director of almost limitless forces.

Trends in Fuel Use in Manufacturing

In the years since 1900, there has been a five-fold increase in the amount of energy consumed annually within the United States. Per capita energy consumption has risen to more than twice its earlier level, increasing from the equivalent of 4 tons of coal in 1900 to more than 9 tons in 1960. With this increase have come very significant changes in the patterns of fuel consumption. Coal which formerly provided most of the energy has been displaced from its position of prominence by petroleum products. Petroleum, in turn, is being rapidly replaced in many of its uses by natural gas. Electricity is tending to supplant the direct use of all three fuels in numerous applications.

For some purposes a specific fuel may possess characteristics that make it especially suitable. The use of natural gas in the manufacture of glass because of convenience and to prevent contamination, the use of petroleum liquid fuels for automobiles and locomotives, and the use of natural gas for home heating are examples. For most industrial uses, however, oil, gas, and coal can perform the service with equally satisfactory results, and where a choice of fuels is possible, the fuel is selected purely on the basis of overall economy.

Trends in the consumption of fuel energy per worker and in the relative quantities of each fuel consumed in selected manufacturing industries are shown in table 9. A very significant downward trend in per-worker fuel consumption may be noted, illustrating the decrease of in-plant use of fuel to provide energy. This has been replaced by electrical energy, commonly transmitted into the plants from outside sources. (See also table 10 and section on Electricity.)

The trends in percent of Btu's provided by the various fuels show a steady replacement of coal by oil and/or gas. Among the most spectacular changes is that the category of "Miscellaneous Manufactures" where coal dropped from 63 percent in 1947 to 25 percent in 1958. Fuel oil showed a significant gain from 1947 to 1954 but none during the next four years. Gas, on the other hand, rose from 6 percent in 1947 to 37.5 percent in 1958.

Coal.—Table 10 shows the consumption of coal within the United States in 1960, by major consumer categories. This consumption of 380 million tons compares with an all-time high of almost 594 million reported in 1943. During that year 130 million tons were consumed by railroads, 102 million was used in coke, 142 million in general industrial categories, and 120 million for retail purposes.

On the other hand, these losses have been offset to some extent by electric power utilities which used only 74 million tons in 1943 as compared to about 174 million tons in 1960.

The loss of markets by coal has resulted from increased competition from other fuels. Coal's ability to hold the electric utility market stems from its low cost and the efficiency in coal combustion in large power plants.

Oil.—Oil provides the greatest share of the fuel energy in the United States today, accounting for about 38.2 percent.

A large portion of the energy provided by petroleum liquid fuels is consumed in transportation. Table 11 shows that almost half of the output of refineries in the United States in 1960 was gasoline. Much of this was, of course, used as fuel for private automobiles, but important quantities were used also by trucks hauling both the raw materials and finished products of industry. Likewise, a very significant portion of the distillate fuel oil was used to power diesel locomotives and trucks.

Table 12 shows the various uses made of distillate and residual fuel oils.

Natural Gas.—Natural gas is the most rapidly growing of the major fuels. In the period 1947-1960, it increased its share of the energy market from 13.8 to 28.3 percent of the total. Much of this growth was made possible by the rapid expansion of the gas pipeline network throughout the country.

About two-thirds of the natural gas consumed goes into various industrial uses (table 13). One-half of the total consumption is as industrial fuel. Part of this industrial fuel is provided on an interruptible basis during summer periods when domestic heating requirements are low and extra gas is available. In such cases the consumer must be capable of switching to other fuels promptly when necessary.

Electric Power

Among the various segments of industry within the United States, the electric power industry has been outstanding in the rate, length, and continuity of its expansion.

In 1960 the combined utility and industrial production of electricity was 840 billion kilowatt hours as compared to 57 billion in 1920, 180 billion in 1940, and 389 billion in 1950. While the estimated total consumption of energy in the United States rose 67 percent during the period 1940-1960, production of electricity increased 367 percent, or more than 5 times as much. Table 14 shows the gain in the use of electric power for various purposes from 1940 to 1960.

A strong trend toward the purchase of electric power from utilities, rather than generating it within individual industrial establishments, is indicated. This is undoubtedly because of the greater efficiency and economy that can be attained by large generating plants.

Although the amount of direct fuel energy consumed per worker in manufacturing concerns has been declining (table 9), the electric energy consumed per worker has shown a marked increase. Table 15 shows trends in the electric power per worker in the major manufacturing categories. A continuing growth is shown in nearly all these groups.

Table 16 gives the 1958 per-worker consumption of electric power in selected industries having especially large power consumption. Most pronounced is that of aluminum reduction plants where consumption approaches 1 1/2 million KWH per worker.

TABLE 1 - ESTIMATED PER CAPITA CONSUMPTION OF MINERAL MATERIALS IN THE UNITED STATES IN 1960*

Energy (in terms of bituminous coal)	9.6 tons
Major metals:	
Steel (Estimated steel in use, 8.4 tons per person)	794.0 lbs.
Copper	15.1 lbs.
Lead	11.4 lbs.
Zinc	9.8 lbs.
Aluminum	22.5 lbs.
Chromium	7.4 lbs.
Manganese	5.8 lbs.
Nickel	1.2 lbs.
Tin	1.1 lbs.
Non-metallic minerals:	
Stone, sand and gravel	14,771 lbs.
Cement	652 lbs.
Clays	541 lbs.
Gypsum	261 lbs.
Common salt	291 lbs.
Phosphate rock	152 lbs.
Lime (other than for cement)	144 lbs.
Sulphur	79 lbs.
Potassium salts	26 lbs.

Among metals consumed in smaller amounts are antimony, magnesium, molybdenum, cadmium, cobalt, tungsten, beryllium, vanadium, niobium, and bismuth.

*Based on estimates of total consumption by the United States Bureau of Mines, and United States population figures of the United States Bureau of the Census.

TABLE 2 - SHIPMENTS OF STEEL PRODUCTS, BY MARKET CLASSIFICATION, IN THE UNITED STATES IN 1960

Market classification	Thousands of short tons	Percent of total
Automotive	14,610	20.5
Warehouses and distributors	12,480	17.5
Construction, including maintenance	9,664	13.6
Containers	6,429	9.0
Machinery, industrial equipment, and tools	3,958	5.6
Contractors products	3,602	5.1
Steel for converting and processing	2,928	4.1
Rail transportation	2,525	3.5
Electrical machinery and equipment	2,078	2.9
Domestic and commercial equipment	1,959	2.8
Appliances, utensils and cutlery	1,760	2.5
Agriculture	1,003	1.4
All other, including exports	8,153	11.5
Total	71,149	100.0

Source: United States Bureau of Mines.

TABLE 3 - CONSUMPTION OF CRUSHED AND BROKEN LIMESTONE AND DOLOMITE, IN THE UNITED STATES IN 1960

Use	Thousands of tons	Value in thousands of dollars
Concrete and roadstone	267,657	$347,428
Cement	79,851	85,652
Flux	30,245	43,328
Agriculture	22,518	38,863
Lime and dead burned dolomite	18,568	29,019
Riprap	9,584	11,982
Railroad ballast	5,428	6,884
Alkali manufacture	2,637	2,961
Filler (not whiting substitute)		
Asphalt	2,391	5,604
Fertilizer	424	1,036
Other	193	805
Limestone sand	1,845	3,004
Glass manufacture	1,232	3,720
Calcium carbide manufacture	1,016	1,092
Sugar refining	875	2,268
Limestone whiting*	657	7,101
Mineral food	568	2,972
Paper manufacture	491	2,052
Fill material	476	366
Coal mine dusting	424	1,668
Filtration	169	269
Poultry grit	146	1,106
Refractory (dolomite)	92	244
Other uses+	1,968	5,312
Use unspecified	938	1,561
Total	450,393	$606,297

* Includes stone for filler for calcimine, calking compounds, ceramics, chewing gum, explosives, floor coverings, foundry compounds, glue, grease, insecticides, leather goods, paint, paper, phonograph records, picture-frame mouldings, plastics, pottery, putty, roofing, rubber, toothpaste, wire coating and unspecified uses. Excludes limestone whiting made by companies from purchased stone.

\+ Includes stone for acid neutralization, carbon dioxide, cast stone, chemicals (unspecified), concrete products, disinfectant and animal sanitation, dyes, electrical products, magnesia, magnesite, magnesium, mineral wool, oil-well drilling, patching plaster, rayons, rice milling, roofing granules, stucco, terrazzo, and water treatment.

Source: United States Bureau of Mines.

TABLE 4 - QUANTITIES AND VALUES OF SAND AND GRAVEL CONSUMED, BY USE, IN THE UNITED STATES IN 1960

Use	Thousands of Tons	Value in Thousands of Dollars
	Common Sand	
Building	122,788	$127,868
Paving	99,241	91,599
Fill	20,355	10,929
Railroad ballast	622	468
Other	4,086	3,384
Total	247,092	$234,248
	Gravel	
Building	107,799	$135,842
Paving	289,148	258,455
Fill	27,908	15,140
Railroad ballast	4,650	3,810
Other	12,343	12,337
Total	441,848	$425,584
	Industrial Sand	
Unground		
Glass	6,433	$ 21,521
Molding	6,063	16,001
Grinding and polishing	1,023	2,030
Engine	890	1,683
Blast sand	679	3,303
Fire or furnace	559	1,214
Filtration	269	624
Oil hydrafrac	153	939
Ferrosilicon	63	173
Other	1,201	3,469
subtotal	17,333	$ 50,957
Ground		
Foundry uses	239	$ 1,368
Pottery, porcelain and tile	184	1,773
Abrasives	162	1,540
Filler	123	752
Glass	47	409
Chemicals	13	139
Enamel	9	108
Unspecified	201	1,914
subtotal	981	$ 8,004
Total	18,314	$ 58,961

Source: United States Bureau of Mines.

TABLE 5 - TONS OF CLAY SOLD OR USED BY PRODUCERS, BY KINDS AND USES, IN THE UNITED STATES IN 1960

Use	Kaolin	Ball clay	Fire clay and stone-ware clay	Benton-ite	Ful-ler's earth	Miscel-laneous clay in-cluding slip clay	Total
Pottery and stoneware:							
Whiteware, etc.	107,751	243,878	-	-	-	-	351,629
Stoneware, including chemical stoneware	-	2,455	14,762	-	-	45,520	62,737
Art pottery, flower pots, and glaze slip	10,780	3,731	12,708	-	-	67,372	94,591
Total	118,531	250,064	27,470	-	-	112,892	508,957
Floor and wall tile	20,515	98,342	129,844	-	-	145,625	394,326
Refractories:							
Firebrick and block	268,009	18,001	4,257,844	-	-	56,698	4,600,552
Bauxite, high-alumina brick	-	-	55,447	-	-	-	55,447
Fire-clay mortar	1,268	-	103,024	-	-	6,512	110,804
Clay crucibles	-	-	25,520	-	-	-	25,520
Glass refractories	-	30,156	10,754	-	-	-	40,910
Zinc retorts and condensers	-	-	54,072	-	-	-	54,072
Foundries and steelworks	-	-	600,851	464,090	-	9,095	1,074,036
Saggers, pins, stilts, and wads	-	9,765	100,709	-	-	-	110,474
Other refractories	82,350	9,480	186,776	10	-	556	279,172
Total	351,627	67,402	5,394,997	464,100	-	72,861	6,350,987
Heavy clay products; Building brick, paving brick, drain tile, sewer pipe, and kindred products	-	12,629	4,221,884		-	19,125,899	23,360,412
Architectural terra cotta	-	-	5,721		-	-	5,721
Lightweight aggregates	-	-	-	-	-	5,504,367	5,504,367

TABLE 5 - Continued

Filler:							
Paper filling	586,660	-	-	-	-	-	586,660
Paper coating	810,136	-	-	-	-	-	810,136
Rubber	321,188	-	-	-	-	-	321,188
Linoleum and oilcloth	13,459	-	6,640	-	-	-	20,099
Paint	69,803	-	-	-	-	-	69,803
Fertilizers	12,886	-	-	-	-	5,900	18,786
Insecticides and fungicides	69,150	-	1,425	26,761	96,793	485	194,614
Plaster and plaster products	2,765	-	-	-	-	-	2,765
Plastics, organic	9,915	-	-	-	-	-	9,915
Other fillers	57,372	4,120	2,440	685	3,802	2,345	70,764
Total	1,953,334	4,120	10,505	27,446	100,595	8,730	2,104,730
Portland and other hydraulic cements	76,005					9,224,941	9,300,946
Miscellaneous:							
Enameling	2,280	-	-	720	-	-	3,000
Filtering and decolorizing (raw and activated earths):							
Mineral oils and greases	-	-	-	106,051	21,198	-	127,249
Vegetable or animal oils and fats	-	-	-	73,595	20,662	-	94,257
Other filtering and clarifying	-	-	-	3,275	1,416	-	4,691
Rotary-drilling mud	-	-	1,880	404,980	55,791	10,121	472,772
Chemicals	28,291	-	103,710	-	-	-	132,001
Absorbent uses	-	-	-	-	186,829	-	186,829
Exports	75,209	-	6,675	58,091	12,035	-	152,010
Other uses	104,659	11,812	12,686	130,542	9,799	79,863	349,361
Total	210,439	11,812	124,951	777,254	307,730	89,984	1,522,170
Grand total: 1960	2,730,451	444,369	9,915,372	1,268,800	408,325	34,285,299	49,052,616

Source: United States Bureau of Mines.

TABLE 6 - CONSUMPTION OF LEAD, BY PRODUCTS, IN THE UNITED STATES IN 1960

Product	Tons	Product	Tons
Metal products:		Chemicals:	
Ammunition	43,577	Tetraethyl lead	163,826
Bearing metals	20,717	Miscellaneous chemicals	2,806
Brass and bronze	20,485	Total	166,632
Cable covering	60,350	Pigments:	
Calking lead	66,527	White lead	8,432
Casting metals	7,023	Red lead and litharge	74,901
Collapsible tubes	8,705	Pigment colors	11,445
Foil	3,684	Other*	3,763
Pipes, traps, and bends	22,119	Total	98,541
Sheet lead	26,607	Miscellaneous uses:	
Solder	60,013	Annealing	5,153
Storage batteries:		Galvanizing	1,383
Antimonial lead	175,458	Lead plating	218
Lead oxides	177,738	Weight and ballast	9,045
Terne metal	1,765	Total	15,799
Type metal	28,159	Other, unclassified uses:	17,273
Total metal products	722,927	Grand total+	1,021,172

* Includes lead content of leaded zinc oxide and other pigments.

\+ Includes lead which sent directly from scrap to fabricated products.

Source: United States Bureau of Mines.

TABLE 7 - CONSUMPTION OF SLAB ZINC, BY USE,
IN THE UNITED STATES IN 1960

Industry and product	Tons
Galvanizing:	
Sheet and strip	196,057
Wire and wire rope	35,262
Tubes and pipe	56,680
Fittings	9,258
Other	74,332
Total galvanizing	371,589
Zinc base alloy:	
Die castings	331,112
Alloy dies and rod	3,442
Slush and sand castings	3,819
Total zinc-base alloy	338,373
Brass products:	
Sheet strip and plate	45,870
Rod and wire	29,971
Tube	8,504
Castings and billets	4,699
Copper-base ingots	9,412
Other copper-base products	567
Total brass products	99,023
Rolled zinc	38,696
Zinc oxide	15,593
Other uses:	
Wet batteries	1,152
Desilverizing lead	2,521
Light-metal alloys	3,181
Other	7,756
Total other uses	14,610
Total consumption	877,884

Source: United States Bureau of Mines.

TABLE 8 - FLUORSPAR (DOMESTIC AND FOREIGN) CONSUMED, BY GRADES AND INDUSTRIES, IN THE UNITED STATES IN 1960

Grade and industry	Consumption* (short tons)
Acid grade:	
Hydrofluoric acid	372,654
Glass	3,874
Enamel	135
Welding rod coatings	861
Nonferrous	-
Special flux, Ferroalloys, Primary aluminum	2,052
Total	379,576
Ceramic grade:	
Glass	22,396
Enamel	4,676
Welding rod coatings	1,192
Nonferrous	-
Special flux, Ferroalloys	5,990
Total	34,254
Metallurgical grade:	
Glass	687
Enamel	4
Welding rod coatings	395
Nonferrous	738
Special flux, Ferroalloys, Primary magnesium	1,732
Iron foundry	11,810
Basic open-hearth steel	168,733
Electric-furnace steel	45,613
Bessemer steel	217
Total	229,929
All grades:	
Hydrofluoric acid	372,654
Glass	26,957
Enamel	4,815
Welding rod coatings	2,448
Nonferrous	738
Special flux	4,166
Ferroalloys	2,543
Primary aluminum, Primary magnesium	3,065
Iron foundry	11,810
Basic open-hearth steel	168,733
Electric-furnace steel	45,613
Bessemer steel	217
Total	643,759

*Glass, enamel, and other (including welding rod coatings, nonferrous, special flux, and ferroalloys), partly estimated from sample canvases of consumers who accounted for more than 95 percent of total usage in 1958.

TABLE 9 - FUELS CONSUMED IN SELECTED MANUFACTURING INDUSTRIES, EXPRESSED IN MILLIONS OF BTU'S PER WORKER, AND PERCENT PROVIDED BY VARIOUS FUELS, 1958, 1954, AND 1947

Manufacturing category	Year	No. of employees	Millions of Btu's/worker	Percent provided by Coal	Coke	Fuel Oil	Gas
Food and kindred products	1958	1,761,816	346	35.6	0.4	24.1	39.9
	1954	1,647,204	411	43.3	0.2	18.2	38.3
	1947	1,441,847	386	62.5	0.9	16.5	20.1
Tobacco manufactures	1958	91,856	97	66.7	0	22.2	11.1
	1954	94,863	105	69.9	0.1	20.0	10.0
	1947	111,782	125	92.9	-	7.1	-
Textile mill products	1958	916,987	168	49.4	0	29.8	20.8
	1954	1,037,440	212	59.0	0.2	30.4	10.4
	1947	1,233,431	200	70.1	0.2	27.6	2.1
Apparel and related products	1958	1,187,840	na*	na	na	na	na
	1954	1,190,064	na	na	na	na	na
	1947	1,081,044	21	72.1	0.4	18.0	9.5
Lumber and wood products	1958	586,753	49	20.7	0	48.3	31.0
	1954	645,936	102	33.2	0.3	36.6	30.2
	1947	635,708	72	50.0	-	43.5	6.5
Furniture and fixtures	1958	350,585	43	60.0	0	20.0	20.0
	1954	340,694	80	62.7	0.4	14.8	22.1
	1947	322,384	100	83.3	0.6	9.3	6.8
Pulp, paper, and products	1958	578,134	1,282	na	na	na	na
	1954	530,210	1,096	56.6	0.1	23.2	20.1
	1947	449,833	1,179	73.5	0	13.4	13.1
Printing and publishing	1958	872,502	na	na	na	na	na
	1954	804,386	na	na	na	na	na
	1947	714,685	27	50.8	0.5	20.3	28.4
Chemical and products	1958	784,927	1,447	42.8	0	8.0	49.2
	1954	739,389	1,540	48.3	0.1	9.3	42.3
	1947	632,319	1,281	61.4	6.8	12.3	19.5
Petrolum and coal products	1958	245,336	3,448	3.5	0	2.6	93.9
	1954	215,843	3,336	5.2	0.2	3.5	91.1
	1947	212,003	2,575	12.3	0.2	4.0	83.5

TABLE 9 - Continued

Manufacturing category	Year	No. of employees	Millions of Btu's/worker	Percent provided by Coal	Coke	Fuel Oil	Gas
Rubber products	1958	335,655	301	60.4	0	18.8	20.8
	1954	246,526	333	70.8	0	14.6	14.6
	1947	259,092	352	81.2	0.1	9.9	8.8
Leather and leather products	1958	359,107	50	61.1	0	27.8	11.1
	1954	356,578	73	61.6	0	26.9	11.5
	1947	383,175	98	85.3	0.1	13.3	1.3
Stone, clay, and glass products	1958	575,717	1,306	39.1	0.5	1.1	59.3
	1954	491,814	1,126	64.4	0.9	17.0	17.7
	1947	462,072	1,664	57.9	1.3	11.4	29.4
Primary metal products	1958	1,135,577	2,208	11.3	52.5	10.9	25.3
	1954	1,157,059	2,558	9.1	48.4	11.8	30.7
	1947	1,157,124	2,525	14.1	55.0	13.2	17.7
Fabricated metal products	1958	1,089,028	106	22.6	3.5	31.3	42.6
	1954	1,019,406	140	29.6	2.8	26.1	41.5
	1947	971,461	130	47.6	8.7	24.6	19.1
Machinery, except electical	1958	1,385,494	66	44.0	3.2	24.2	28.6
	1954	1,541,675	130	42.3	4.5	22.9	30.3
	1947	1,545,323	125	57.0	8.8	19.7	14.5
Electrical machinery	1958	1,198,926	48	42.1	0	24.6	33.3
	1954	959,126	85	46.6	0.6	25.8	27.0
	1947	801,359	103	66.7	6.1	17.0	10.2
Transportation equipment	1958	1,635,881	120	48.7	1.1	21.8	28.4
	1954	1,704,572	119	54.7	2.5	19.9	22.9
	1947	1,181,680	157	64.0	4.8	17.2	14.0
Instruments and related products	1958	304,336	39	84.6	0	7.7	7.7
	1954	272,586	88	58.1	0.5	20.7	20.7
	1947	231,997	62	69.9	0.7	21.0	8.4
Miscellaneous Manufactures	1958	579,357	27	25.0	0	37.5	37.5
	1954	695,917	118	32.8	0.3	37.7	29.2
	1947	464,420	85	63.0	0.8	30.2	6.0

*Not available
Source: Census of Manufactures

TABLE 10 - CONSUMPTION OF BITUMINOUS COAL AND LIGNITE, BY CONSUMER CLASS, IN THE UNITED STATES IN 1960

Consumer class	Thousands of tons	Percent
Electric power utilities	173,882	45.7
Coke plants	81,015	21.1
General industrial use	76,487	20.1
Retail	30,405	8.0
Cement mills	8,216	2.2
Steel and rolling mills	7,378	2.0
Class I railroads	2,101	.6
Bunker, foreign and lake vessel	945	.3
Total of classes shown	380,429	100.0

Source: United States Bureau of Mines

TABLE 11 - OUTPUT OF REFINED PETROLEUM PRODUCTS BY UNITED STATES REFINERIES IN 1960

Product	Thousands of barrels	Percent of total
Gasoline	1,510,134	49.2
Distillate fuel oil	667,050	21.7
Residual fuel oil	332,147	10.8
Kerosine	135,772	4.4
Asphalt	98,671	3.2
Jet fuel	88,248	2.9
Liquefied petroleum gas	77,578	2.5
Lubricants, wax, road oil and others	161,384	5.3
Total	3,070,984	100.0

Source: United States Bureau of Mines.

TABLE 12 - SALES OF DISTILLATE AND RESIDUAL FUEL OILS, BY USE, IN THE UNITED STATES IN 1960

Use	Distillate Oil		Residual	
	Thousands of barrels	Percent	Thousands of barrels	Percent
Heating oils	422,855	61.9	125,088	22.7
Railroads	86,490	12.7	5,610	1.0
Diesel fuel	74,562	10.9	-	-
Industrial (Excluding oil co. use)	34,271	5.0	157,270	28.6
Bunkering of vessels (Excluding military)	18,730	2.7	94,084	17.1
Range oil	15,155	2.2	-	-
Military	10,793	1.6	31,724	5.8
Oil company use (Excluding heating)	8,347	1.2	45,061	8.2
Gas and electric public utilities power plants	4,742	0.7	85,408	15.5
Miscellaneous	7,380	1.1	6,291	1.1
Total	683,325	100.0	550,536	100.0

Source: United States Bureau of Mines.

TABLE 13 - CONSUMPTION OF NATURAL GAS, BY USE, IN THE UNITED STATES IN 1960

Use	Quantity in millions of cubic feet	Percent of total	Average cost in cents per M.C.F.
Residential	3,103,167	24.8	103.4
Commercial	1,020,222	8.2	77.5
Industrial:			
Fuel			
Refinery fuel	775,154	6.2	
Gas pipelines	347,075	2.8	
Other industrial fuel*	5,286,510	42.2	
Total fuel	6,408,739	51.2	31.7
Field use	1,779,671	14.2	12.4
Carbon black	197,628	1.6	10.0
Total of classes shown	12,509,427	100.0	

* Includes electric utility fuel
Source: United States Bureau of Mines.

TABLE 14 - CONSUMPTION OF ELECTRIC POWER, BY MAJOR CONSUMER CATEGORIES, IN THE UNITED STATES IN 1940 AND 1960

Use	1940		1960		
	Millions of KWH	Percent	Millions of KWH	Percent	Increase in use (percent)
Residential	24,068	14.9	198,070	25.7	723
Commercial	22,373	13.8	118,801	15.4	431
Industrial:					
Provided by utilities	54,320	33.5	328,367	42.5	505
Generated by industrial establishments	38,070	23.5	87,596	11.4	130
Miscellaneous Light and power	23,173	14.3	38,486	5.0	66
Total of categories shown	162,004	100.0	771,320	100.0	322

Source: Federal Power Commission

TABLE 15 - ELECTRIC POWER USED PER WORKER, BY MANUFACTURING GROUPS, IN THE UNITED STATES IN 1958, 1954, AND 1947

Industry group	No. of U.S. employees 1958	Total kw-hrs* used in millions, 1958	Kw-hrs per worker 1958	1954	1947
Food and kindred products	1,761,816	17,711	10,052	8,190	7,043
Tobacco manufactures	91,856	458	4,986	3,480	1,959
Textile mill products	916,987	12,198	13,302	11,827	8,140
Apparel and related products	1,187,840	944	795	1,021	762
Lumber and wood products	586,753	4,372	7,451	6,609	3,678
Furniture and fixtures	350,585	1,457	4,156	3,570	2,872
Pulp, paper and products	578,134	29,274	50,635	44,396	34,204
Printing and publishing	872,502	3,015	3,455	2,095	1,789
Chemicals and products	784,927	101,544	129,368	83,009	31,013
Petroleum and coal products	245,336	13,312	54,261	48,994	30,651
Rubber products	335,655	5,459	16,263	15,207	13,296
Leather and leather products	359,107	937	2,609	2,050	1,235
Stone, clay, and glass products	575,717	14,357	24,938	23,531	17,093
Primary metal products	1,135,577	70,528	62,108	62,690	35,126
Fabricated metal products	1,089,028	7,287	6,691	5,785	4,016
Machinery, except electrical	1,385,494	8,094	5,842	5,228	3,832
Electrical machinery	1,198,926	8,013	6,684	5,843	4,512
Transportation equipment	1,635,881	13,644	8,340	5,102	5,229
Instruments and related products	304,336	1,437	4,721	3,647	2,349
Miscellaneous manufactures	579,357	1,571	2,711	6,470	2,399

Total quantity of electric power used:

Total quantity of electric power used:	1958	318,059 million kw-hrs
	1954	247,666 million kw-hrs
	1947	140,947 million kw-hrs

* Purchased plus generated minus sales

Source: Census of Manufactures for 1958, 1954, and 1947.

TABLE 16 - CONSUMPTION OF ELECTRIC POWER
IN SELECTED INDUSTRIES IN 1958

Industry	Number of employees	Kilowatt hours consumed (millions)	Kilowatt hours per worker
Alkali and chlorine chemicals	20,476	7,393	361,000
Fibers, plastics and rubbers	121,536	5,276	43,311
Cement	41,127	6,910	168,015
Blast furnaces and steel mills	511,392	28,821	56,358
Aluminum reduction	17,381	25,138	1,446,300

Source: Census of Manufactures for 1958

PART III. THE ILLINOIS-MISSOURI RESOURCE BASE

Non-Fuel Mineral Resources

Iron- and Steel-Making Materials

Iron ore, coking coal, and limestone—the three basic ingredients in the process for the production of iron—are all found within a radius of less than 90 miles from Greater St. Louis. Fluorspar, essential to the manufacture of steel, is found at only a slightly greater distance. Figure 3 shows the location of these important minerals. The locations of iron ore in Missouri, coking coal and fluorspar in Illinois, and high-grade limestone deposits on both sides of the Mississippi are shown.

Steel plants are in operation at three points shown on the map—Granite City, Alton, and Peoria. The Granite City plant, producing about 1 1/4 million tons per year, is the largest plant in the area and is the only one at which blast furnaces are in operation.

Iron Ore.—Missouri has been a producer of iron ore for almost a century and a half (Bishop, 1949, p. 33). First recorded mining of iron ore in Missouri was in 1815. Maximum production, almost 428 thousand long tons, took place in 1887 and during this same year 124 thousand tons of pig iron was produced within the state. As the rich iron ores of the Lake Superior region gained favor because of their high grade, ease of mining, and their proximity to low-cost transportation, iron ore production in Missouri suffered a long period of decline until in 1933 no production was reported. Since then, iron ore mining within the state has made a strong comeback. In 1960, production of 863 thousand long tons of crude ore, equivalent to 404 thousand tons of usable ore, was reported. Recent developments promise to increase greatly the importance of Missouri as an iron ore producing state.

About 90 percent of the iron ore mined thus far in Missouri has been hematite. Specular hematites, directly associated with rhyolite porphyries in the area of Iron Mountain, have been the principal source. The general region of occurence lies where the borders of Iron, St. Francois, and Madison Counties join. This is the easternmost Precambrian iron ore region shown on the map in figure 3.

Most of the Missouri iron ore in recent years has come from the Iron Mountain Mine, now operated by the Midwest Ore Company (Christiansen, 1962). The ore consists principally of a hard blue specular hematite, although in places magnetite may be present in quantities constituting as much as 25 percent of the ore content. The natural ore, averaging about 35 percent in iron content, is crushed and processed to form a 54+ percent concentrate for blast furnace use. Reported production in 1960 was 255,000 tons of concentrates (Hensen, 1961).

Sedimentary iron ores have provided most of the remainder of the iron mined in Missouri. The areas in figure 3 designated by Roman numerals I through V have been indicated by the Missouri Division of Geological Survey and Water Resources as principal sedimentary iron ore districts of the state (Hayes, 1957) Although some specular hematite is found among the sediments of these regions, limonite is

the principal type of ore. Limonite ores are distributed widely and are found to some extent in nearly every county in the Missouri Ozark region. The deposits are numerous and small and, for the most part, occur within residual clays as small masses or large ledge-like masses. The presence of silica and of iron sulfides, and the difficulty of separating them from the clay, hinder the satisfactory preparation of these ores for use and tend to increase production costs.

Another factor that has retarded the development of the sedimentary ores is the variation in ore characteristics and purity from one deposit to the next. This prevents large shipments of a uniform grade of ore. On the other hand, the low phosphorous content of the sedimentary ores makes them useful for blending with other ores containing a greater percentage of phosphorous.

District Number I is the West Plains District. It encompasses Howell and Oregon Counties and parts of Ozark, Douglas, Texas, and Shannon Counties. Ore within the district is chiefly limonite and occurs as boulder, tabular, and pipe ore, and as ocher. The deposits are of secondary origin and are found in a thick blanket of residual clay and chert. Iron content is reported at about 53 to 55 percent.

District II is the Poplar Bluff District and extends from Ripley County northeast across Carter, Wayne, and most of Madison County. Parts of Reynolds and Butler Counties are included also. Both primary and secondary limonite deposits are found within the area, occuring mostly as boulders irregularly distributed in a residuum of cherty clay. Average iron content is about 46 percent according to reports of the Missouri Geological Survey.

The Osage River District, shown as District Number III, includes parts of Benton, Hickory, Morgan, Camden, Miller, Osage, Maries, and Gasconade Counties. Most of the ore occurs as secondary limonite boulders and pipe ore. In central and southeastern Miller County a number of hematite deposits occur.

District IV, the Springfield District, lies at the western edge of the map, mostly in Polk and Greene Counties. Ore within this district consists chiefly of secondary brown ore (limonite) deposits in the form of fragments and boulders lying within cherty clay. Iron content of the ore runs about 50 percent. Phosphorous, averaging about 0.2 percent, is generally several times as high as that in the ores of the other districts.

The Steelville District, shown as Number V on the map, covers Dent, Phelps, and Crawford Counties, together with southern Gasconade and Franklin Counties and western Washington County. In this district, both limonite and hematite are found. Soft red hematite and quantities of hard blue specular hematite boulders from most of the ore. These deposits are found, to a large extent, as fill materials within the sinks occuring in the dolomites and sandstones of the region.

Thus far, the only magnetite ore marketed from Missouri has been a small quantity mined with the hematite ores in the areas of Iron Mountain and Shepherd Mountain. Recent discoveries, however, promise to make magnetite the most important ore within the state.

The existence of magnetic disturbances in east central Missouri has been well known for many years. In the late 1940's extensive airborne magnetometer surveys, jointly sponsored by the Missouri Division of Geological Survey and Water Resources, the U. S. Geological Survey, and interested mining companies, were flown over the area and a number of important magnetic anomalies were pin-pointed. Subsequent drilling has indicated that at least three magnetic iron ore deposits of major significance lie within the area (Chamber of Commerce of Metropolitan St. Louis, 1960).

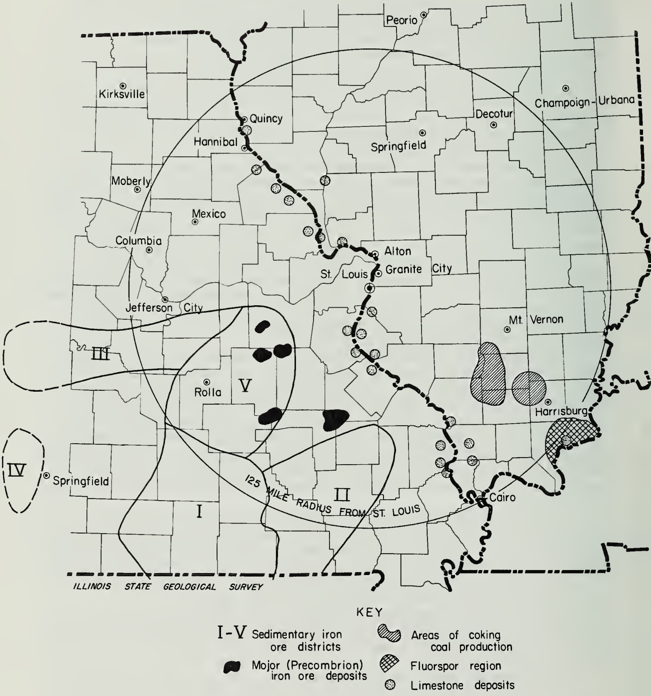


Fig. 3 - Iron and steel resources and operations

One new mine is being developed at Pea Ridge, in the northwestern corner of Washington County, where the Mermac Mining Company is sinking shafts to develop a massive underground deposit of magnetite and hematite with an iron content reported at 55 to 58 percent. The size of the orebody has been estimated at 100 million tons. According to published reports the plan is to produce about 3 million tons of ore each year which, in turn, will be pelletized to form 2 million tons of concentrate. Production will begin in 1963.

A few miles to the west, in Bourbon, Crawford County, another anomaly is being investigated jointly by the American Zinc, Lead and Smelting Company and the Granite City Steel Company (Hayes, 1959, p.14). This deposit, too, was recently reported to contain 100 million tons of commercial-grade iron ore. Still another anomaly, near Kratz Spring, Franklin County, is reported to be of promising character.

About 35 miles to the south of the Pea Ridge and Bourbon deposits, the Granite City Steel Company and the American Zinc, Lead and Smelting Company have reported an iron and copper ore deposit in the Boss-Bixby area (Hayes, 1959, p. 16).

Currently, Missouri provides about one-third of the 1,600 thousand tons of iron ore consumed within the area annually, with the balance coming principally from Minnesota and Michigan. Completion of the projects now under way will raise production considerably above the amount being consumed at present and would support a considerable expansion in iron- and steel-making capacity.

Coking Coal.—Approximately 1.4 tons of coking coal is used in the manufacture of 1 ton of coke. For every ton of pig iron or hot metal produced in the United States in 1960, an average of about 0.75 tons of coke was consumed in the process. Most of the coal used in the manufacture of metallurgical coke in the Missouri-Illinois region comes from southern Illinois coal mines. Illinois coal currently being consumed in coke production is mined from the areas shown in figure 3. The high-volatile coals from southern Illinois are mixed with low-volatile Pocahontas coal from the southern Appalachian coal fields to form a blend containing 75 percent Illinois coal. In recent years approximately one-half million tons of Illinois coal has been consumed each year at Granite City coke ovens. Additional tonnages have gone to the steel industry in the Chicago area. With recent expansion of coke-oven capacity at the Granite City Steel Company plant, annual consumption of Illinois coal there should approach 900 thousand tons. This will be more than six times the 140 thousand tons of Illinois coal consumed in coke production during the year 1944. About 200 thousand additional tons are consumed annually in the Chicago area.

The growing acceptance of Illinois coal for the manufacture of metallurgical coke can be attributed primarily to two things. First is the coking research program carried on by the Illinois State Geological Survey, in close cooperation with the steel and coal industries, which showed that suitable coke can be made with Illinois coal (Jackman et al., 1956, 1959). Second is the improved competitive position of Illinois coal (Risser, 1962). This improved position has resulted from the preparation of the coal by the producer in order to obtain a higher quality and more uniform product, greater mining efficiency obtained through large-scale mechanization, and the steadily increasing spread between the cost of shipping coal to Granite City from the eastern coal fields and the cost of shipping from southern Illinois. Currently (1962), this spread is $3.27 per ton in favor of southern Illinois coal.

Fig. 4 - Location of limestone and dolomite quarries, and lime and cement plants

Limestone.—In addition to the necessary iron ore and coke used, approximately 500 pounds of high quality limestone, for flux, is consumed in the production of each ton of pig iron. Large tonnages of limestone currently are being produced for this purpose near Valmeyer, Illinois. Known deposits of high grade stone also occur almost directly across the Mississippi in Jefferson and Ste. Genevieve Counties, Missouri, and on both sides of the Mississippi not far from Quincy, Illinois. Tests and analyses by the Illinois State Geological Survey and the Missouri Division of Geological Survey and Water Resources indicate that sufficiently high quality limestone may be available at numerous other spots in both states along the Mississippi River as shown in figure 3.

Fluorspar.—Fluorspar, used as a fluxing material in steel-making operations, is produced from deposits in Pope and Hardin Counties in southeastern Illinois (fig.3). These deposits, about 125 miles southeast of St. Louis, provide about 60 percent of the fluorspar produced within the United States each year (Finger et al., 1960). Although currently depressed by competition from imports of foreign fluorspar, the deposits of this region have made Illinois the country's leading fluorspar producer for many years.

Construction Materials

Stone.—Limestone and dolomite are produced from numerous deposits scattered widely throughout the area as shown in figure 4. Also shown are the locations of cement plants and lime plants within the area.

Cement provides the greatest mineral value within the state of Missouri each year. Three of the four cement-producing counties of the state lie within the area shown in figure 4. Four plants are in operation. Currently (1962), no cement is produced within the portion of Illinois shown. However, the cement industry is expanding to meet growing demand and a new plant is under construction on the Ohio River near Joppa, Illinois. Geologic studies indicate that resources are available for a considerable expansion of the cement industry in Illinois and Missouri (Lamar et al., 1956; Buehler, 1907).

Lime plants are operating in Ralls, Ste. Genevieve and Cape Girardeau Counties in Missouri and in Adams County, Illinois.

Deposits of rock suitable for use as building stone also are available in the area. In Illinois, sandstone and limestone currently are produced for this purpose. Marble deposits occurring within the state have not been developed yet. In Missouri, limestone, sandstone, and granite, and marble are produced in various locations throughout the area (fig. 4). Dimension granite is produced in Iron County, marble in Ste. Genevieve County and sandstone in Shannon County.

Sand and Gravel.—Illinois and Missouri have large production of common sand and gravel; most of it comes from deposits along the major streams of both states and the glacial deposits of northern and central Illinois (fig. 5).

Special sands and industrial sands, the most important of which is silica sand, are also produced within the area. Silica sand is produced in a number of locations west of St. Louis and along the west side of the Mississippi River south of St. Louis. Undeveloped deposits of sandstone possessing a high silica content occur in extreme southern Illinois. Deposits of tripoli and ganister, consisting principally of very fine particles of silica, are being mined in southwestern Illinois.

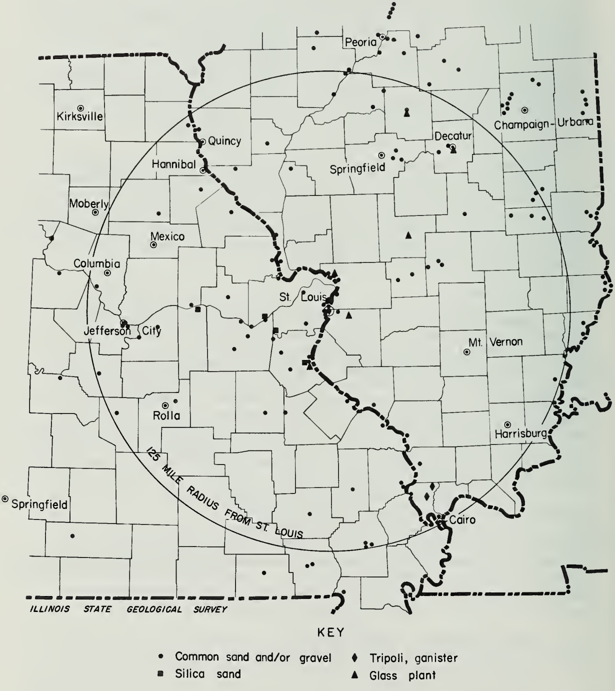
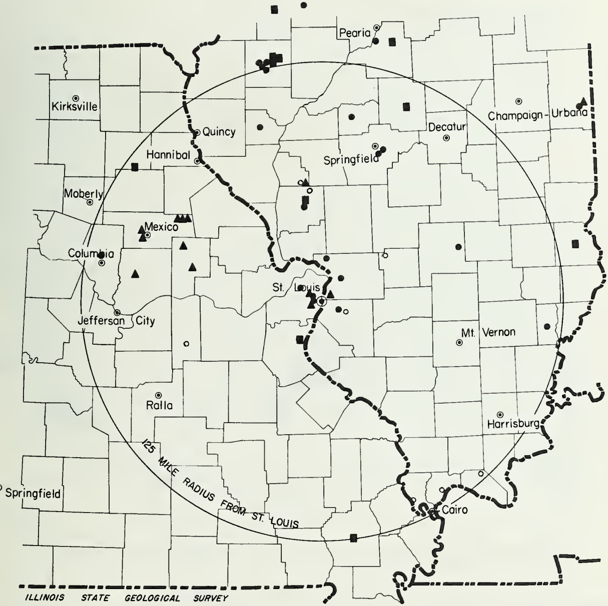


Fig. 5 - Location of sand, gravel, and silica production and glass plants



KEY

● Brick, tile, aggregate ○ Clay grinding plants
■ Pottery, whiteware ▲ Brick refractories

Fig. 6 - Clay and ceramic operations

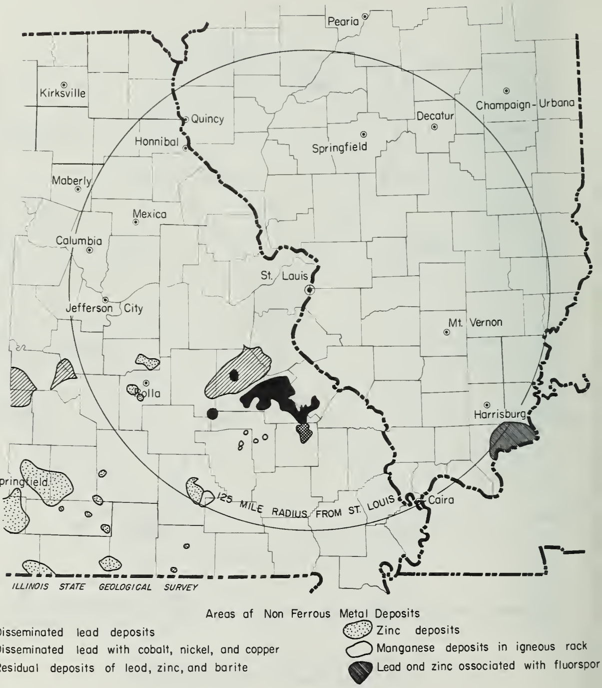


Fig. 7 - General areas of deposits containing ores of nonferrous metals

A major use of silica sand is in the manufacture of glass. A number of glass plants are operation within the area as shown in figure 5.

Clay Products.—Numerous plants manufacturing ceramic goods of various types are within the territory. The location of these plants is shown in figure 6. Products include construction materials such as common and face brick, tile, lightweight aggregate, and refractories; pottery and whiteware are also produced.

Of major significance are the deposits of excellent refractory clays of northeastern Missouri, especially those occurring in Audrain County. These deposits and the refractory goods produced from them are of international repute. Such products are used for constructing fire resistant linings in metallurgical and other high-temperature furnaces.

Nonferrous Metals

Ores of a number of base or nonferrous metals are found within the region. The general areas of their occurrence are shown in figure 7.

Lead.—Lead was first mined commercially in Missouri about 1720 and the state has been an important lead producer since that time. In 1960 Missouri provided about 45 percent of the total primary lead production in the United States. Principal among the nonferrous metallic deposits of the area are the disseminated lead deposits of the famous Southeast Missouri Lead Belt lying in the Flat River-Bonne Terre region of St. Francois County. To the west, mines at Viburnum in Iron County and Indian Creek in Washington County also are exploiting major deposits. Most of the lead produced within the area is smelted and refined at Herculaneum, Missouri

Residual deposits lying in the Central District, southwest of Jefferson City, were important sources of lead during the third quarter of the nineteenth century. The ores in the Central District declined in importance after 1880, with growth of mining in the richer Southeast Missouri Lead Belt and the Joplin District (Bishop, 1949, p. 44).

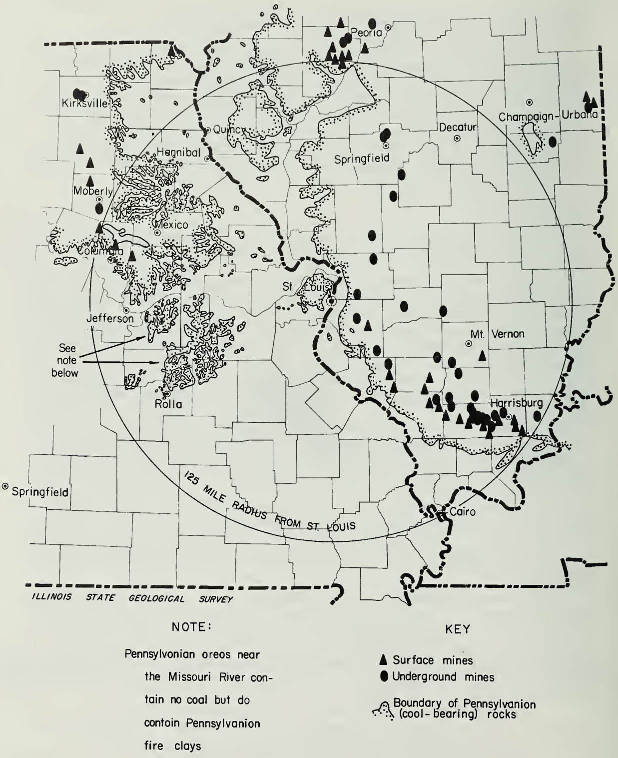
In the Illinois portion of the area under study small quantities of lead are produced in conjunction with the mining of fluorspar in Pope and Hardin Counties.

Other Metals.—In addition to the well-known lead deposits of southeastern Missouri, deposits containing zinc, copper, nickel, cobalt, and barite also are present (fig.7).

Zinc occurs in association with lead in the residual deposits of the Central Region in Missouri. Zinc ores also are found to the east and southeast of Springfield, Missouri. Currently, the price of zinc is too low to justify any appreciable production. In 1960, zinc production was reported from only St. Francois and Washington Counties in Missouri where it was produced in conjunction with lead mining. In Pope and Hardin Counties, Illinois, small quantities are recovered in fluorspar production.

Copper is associated with some of the lead deposits of Missouri. Cobalt and nickel occur in complex ores containing lead and copper. Small quantities of cadmium, gallium, germanium, and indium are present as trace elements in the lead-zinc ores of Missouri. These are recovered from the flue dust of zinc smelters.

Manganese-bearing igneous rocks occur within an area southwest of the principal lead deposits in southeast Missouri. Exploitation of these is not economically feasible at the present time.



NOTE:

Pennsylvanian areas near the Missouri River contain no coal but do contain Pennsylvanian fire clays

KEY

▲ Surface mines
● Underground mines
Boundary of Pennsylvanian (coal-bearing) rocks

Fig. 8 - Coal mines and resources

Miscellaneous Minerals

A number of other mineral materials are available within the area. Missouri possesses important deposits of barite (Muilenburg, 1948), and in Illinois some barite occurs with the fluorspar in the southeastern part of the state (Bradbury, 1959). Missouri is the second-largest producer of barite in the United States, and its production of 181,000 tons in 1960 accounted for about 25 percent of the total United States output during that year. Ninety-four percent of the barite consumed in 1960 went into well-drilling muds. The remainder was used in the manufacture of paint, rubber, glass, chemicals, and miscellaneous other products.

Agate and other varieties of stone are produced for gemstones in small quantities in Missouri.

Water

Research on the availability and quality of water within the area has been done by the Illinois State Water Survey, the Illinois State Geological Survey, the Missouri Division of Geological Survey and Water Resources, and the United States Geological Survey. (See page 60.) Ground water and/or surface water are present for industrial purposes throughout much of the area, and additional reservoirs and lakes have been advocated in many locations to supplement that now available.

Much of the ground water available in the area lies within glacial deposits and in the alluvial deposits of major river valleys. Sandstone and limestone strata also are water-bearing in parts of the region. The Mississippi, Illinois, Missouri, Ohio, and Wabash Rivers, together with their tributaries, provide surface water. Average annual rainfall (St. Louis) is 37.86 inches.

Fuels and Electric Power

Any large-scale industrial development is highly dependent on the ready availability of tremendous quantities of energy. To be suitable for industrial use, energy must not only be available in large quantities but must be available at a reasonable cost. In this respect the area under study enjoys an extremely favorable position, primarily because of the large quantities of thick, easily-mined coal it possesses.

A study of fuel consumption and costs by manufacturing concerns was made a number of years ago (United States Bureau of the Census, 1948). The low cost of coal used by manufacturing concerns in the St. Louis Standard Metropolitan Area was matched by only 4 of the 148 areas reported.

The comparison of the cost of fuel for the generation of electric power provides another example of the low cost of coal within the area. Of the eight metropolitan areas having greater population than St. Louis only one, Pittsburg, Pennsylvania, has a lower reported fuel cost per million Btu's. If only the Illinois portion of the St. Louis Standard Metropolitan Area is considered, then the cost is even lower than for Pittsburgh.

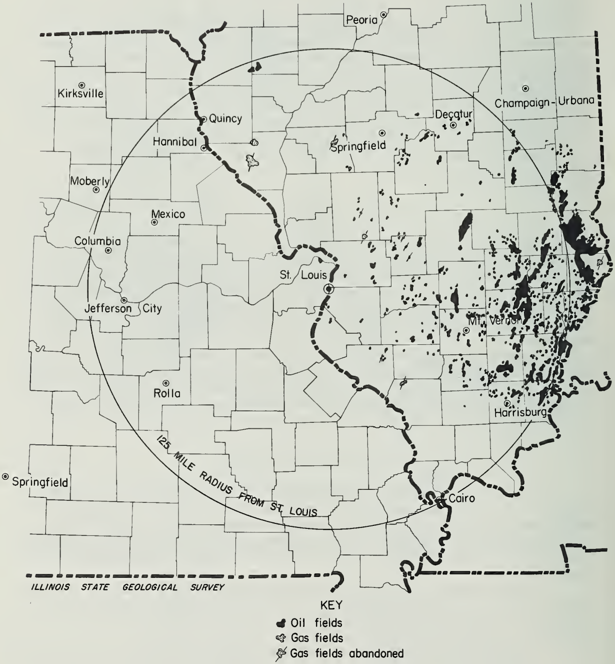


Fig. 9 - Oil and gas fields

Fuels

Coal.—The Illinois-Missouri area possesses tremendous energy resources, primarily in the form of the huge coal deposits lying within the area (fig. 8). Of the 137 billion tons of minable coal in Illinois, about 103 billion tons lie within 125 miles of St. Louis (Cady et al., 1952). Twenty-five to 30 billion tons of this coal is less than 50 miles away. Much of the coal lies at depths sufficiently shallow to be mined by surface mining methods. Along the western edge of the coal fields, from Cass County southward, an estimated 4.5 billion tons is covered by overburden less than 100 feet in thickness (Smith, 1957, 1958, 1961). Another 3 billion tons lies under cover ranging from 100 to 150 feet. Of the coal that is too deep to strip, the greater portion lies in thick, relatively level beds that are susceptible to mining by the most modern and efficient underground mining methods.

During 1960, Illinois produced 45.8 million tons of coal, of which almost 40 million tons was mined within the 125 mile radius. Within the Illinois Basin, the thick No. 6 and No. 5 beds provide the greatest quantity of the coal produced. Beyond the limits of these coals some thinner beds are being mined.

Coal has been mined for many years on the Missouri side of the Mississippi River (Henson, 1949, p.22). Portions of the City of St. Louis now stand above early coal-mine workings. At the present time (1962), coal is being mined in four Missouri counties lying within the 125-mile radius. These are Boone, Callaway, Ralls, and Randolph Counties, where 173,000 tons of coal were produced in 1960. In the northwestern corner of the map (fig.8), three adjoining counties—Adair, Clark, and Macon—accounted for another 639,000 tons. The Peabody Coal Company recently announced plans for the construction of a new mine near Columbia, Missouri, to produce 400 to 500 thousand tons per year.

The coal beds of eastern Missouri, like those of parts of western Illinois, are relatively thin and shallow and most of the coal production is by strip-mining methods.

Oil.—Oil constitutes a second major energy fuel resource within the area. The oil fields, as shown in figure 9, are concentrated for the most part in the deep, central part of the Illinois Basin. Seventy-five to eighty million barrels of oil per year are produced from these fields (Bell et al., 1961).

Up to this time, oil has been produced from only one pool within the portion of Missouri included in this discussion. This was the Florissant pool, located just north of St. Louis.

Large quantities of crude oil, principally from the southwestern United States, come into Illinois for refining. Meanwhile, approximately 70 percent of the crude oil produced in Illinois moves into other states to be refined. About 190 million barrels of crude oil are refined within Illinois each year.

Figure 10 shows the trunk oil lines in the area. Local gathering lines are not included. Also shown on the map is the location of oil refineries. The refineries shown have a capacity of more than 400 thousand barrels of crude oil per day, almost 300 thousand of which are provided by plants within the St. Louis Metropolitan Area.

Natural Gas.—Natural gas also is an important fuel for many uses within the area. No natural gas comes from the Missouri portion of the area and only a relatively small quantity of natural gas, ranging from 400 to 500 million cubic feet

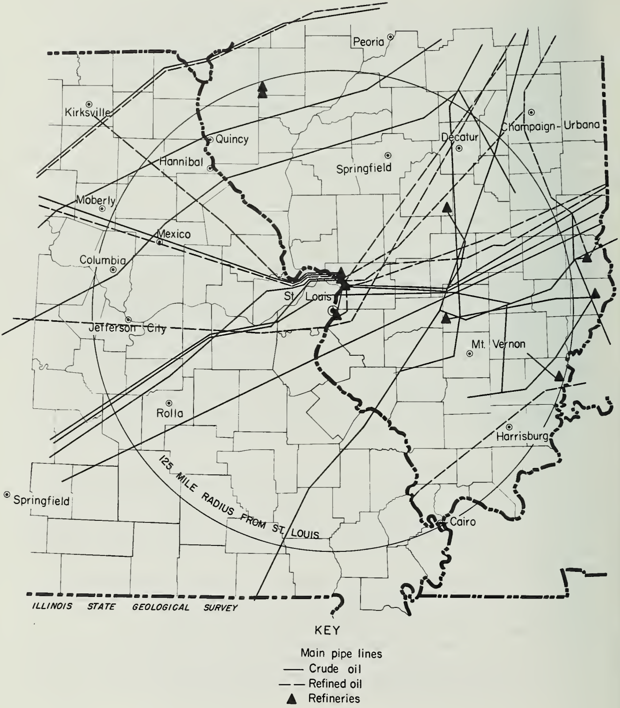


Fig. 10 - Oil refineries and pipelines

Fig. 11 - Natural gas pipelines

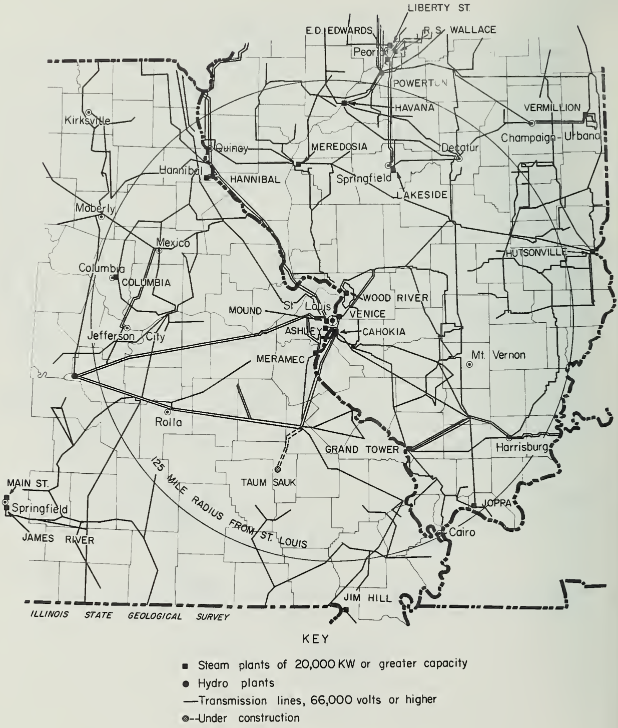


Fig. 12 - Electric-power distribution lines

per year, is produced in Illinois. Nearly all the gas consumed within the area is supplied by pipelines from the southwestern United States. The major gas transmission lines are shown in figure 11; local or regional distribution lines are not included. A new 600-mile pipeline from western Oklahoma to St. Louis has been proposed but not yet approved. If this is completed, additional gas will be available for industrial and other purposes.

Gas storage reservoirs, shown in figure 11, are used to more fully utilize the long-distance transmission lines during periods of low demand and increase the availability of gas during peak demand (Bell, 1961). These reservoirs consist of underground rock formations porous enough to receive gas pumped from the surface through drill holes and so shaped that the gas will be confined by overlying impervious rock layers. Surplus pipeline gas is injected into the reservoir and withdrawn when needed.

Electric Power

Most energy released through the combustion of fuels is applied directly to the performance of a specific task. However, about one-sixth of the total fuel energy consumed within the United States is used for the generation of electricity which, in turn, is used in this form.

The economical conversion of heat energy from the fuels into electrical energy requires large and efficient power generation plants. Vast networks of electric power transmission lines are required to move the power from generating plant to point of use.

Power transmission lines of 66,000 and higher voltages are shown in figure 12. Also indicated are the names and locations of steam power plants having a capacity of 20,000 kilowatts or more. The combined 1961 capacity of the plants shown exceeds 5.1 million kilowatts of which 4.4 million is in Illinois. Plants in the St. Louis Metropolitan Area have a capacity of almost 2 million kilowatts of which 55 percent is in the East St. Louis-Wood River region.

During 1960 the total output of the plants shown in figure 12 was 26 billion kilowatt hours (National Coal Association, 1960). Coal produced 93.0 percent, oil about 0.5 percent, and natural gas 6.5 percent of this power. Reported cost per million Btu's as consumed, ranged from a low of 18.7 cents to a high of 32 cents, with an average of 21.3 cents. This compares with an average of 26.0 cents for total coal consumed by electric utilities throughout the United States during 1960.

In order to keep abreast of growing demands, generating capacity and transmission lines are being expanded constantly. A new Union Electric Company plant is under construction near Taum Sauk in Iron County, Missouri. It will be a "pumped storage" plant with a 350,000 kilowatt capacity. Surplus electrical energy, available during hours when demand is low, will be used to pump water into a storage reservoir on the mountain behind the plant. During the peak demand periods, the water will flow from the high reservoir through the combination pump-turbines to provide generation of hydroelectric power.

Public announcement has been made of plans by the Illinois Power Company for a 1-million kilowatt plant near Baldwin, Illinois. The Central Illinois Public Service Company has announced its intention to build a plant of 350,000 kilowatt near Coffeen, Illinois. Other large plants are under consideration or in the planning stage at present.

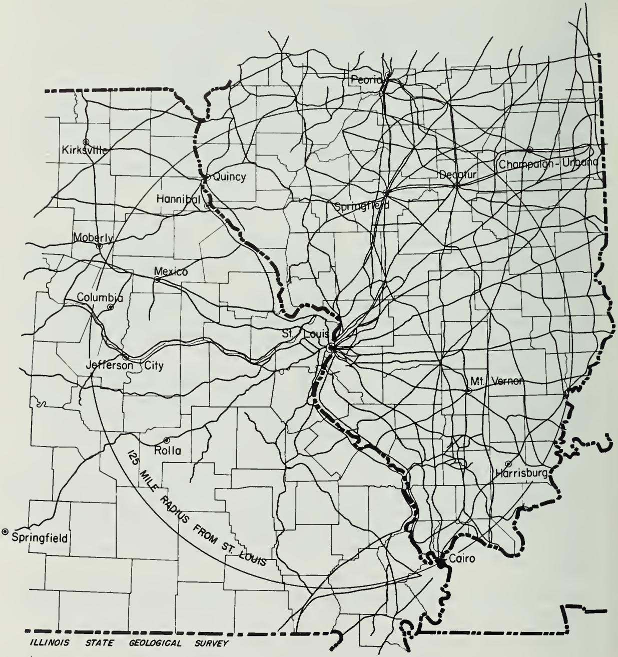


Fig. 13 - Network of railways

Transportation

The Illinois-Missouri area under discussion is fortunate in having, within a relatively short distance of each other, a combination of nearly all the major mineral commodities required for industrial development. Nevertheless, large-scale and low-cost transportation facilities are necessary in order to assemble economically and efficiently these materials for processing and use. Likewise, good transportation is required for movement of finished products to market.

Within the area studied, transportation facilities for rail, water, pipeline, and highway shipment are available.

Railroads

Figure 13 shows the network of railways crisscrossing the area. Examination of this map indicates that within the vast Illinois coal fields there is no point that is more than 12 miles from a railroad. Most of the coal lies within 5 miles or less.

Eighteen trunk lines enter the St. Louis area from the surrounding territory. Six short lines and switching lines also serve the area. These make St. Louis the second largest railroad terminal in the United States.

It is estimated that more than half of the tonnage carried by the railroads of the region is of mineral origin.

Waterways

Another medium of transportation is the inland waterway system (fig. 14) which provides low-cost bulk transportation within the area. A nine-foot channel permits the passage of large barges throughout much of the territory. Some tributaries also have been canalized, but to lesser depth, and plans are under way for canalizing still other streams. Congress has authorized a study of a proposed 50-mile improvement of the Kaskaskia River from the Mississippi to Fayetteville, Illinois. This would make water transportation available to large coal reserves situated along that stream.

Canalization of the Big Muddy River from the Mississippi to the vicinity of Benton, Illinois, and of the Saline River to the vicinity of Harrisburg, Illinois, also has been advocated as has canalization of the Wabash River. Completion of these projects also would provide water transportation for large reserves of coal.

Minerals account for the greater portion of the tonnages moved by waterway. On the Illinois Waterway in 1960, for example, petroleum products accounted for 20.5 percent of the total tonnages moved, bituminous coal for 26.3 percent, and sand, gravel, and crushed stone for another 11.2 percent. These three items totaled 58 percent of all cargo tonnage. If iron and steel products and other products make from minerals are added to this, they account for about 86 percent (U. S. Army Corps of Engineers, 1961).

Of 123 loading docks and terminals on the portions of the Mississippi and Illinois Rivers shown in figure 14, 87 are mineral loading and/or unloading facilities.

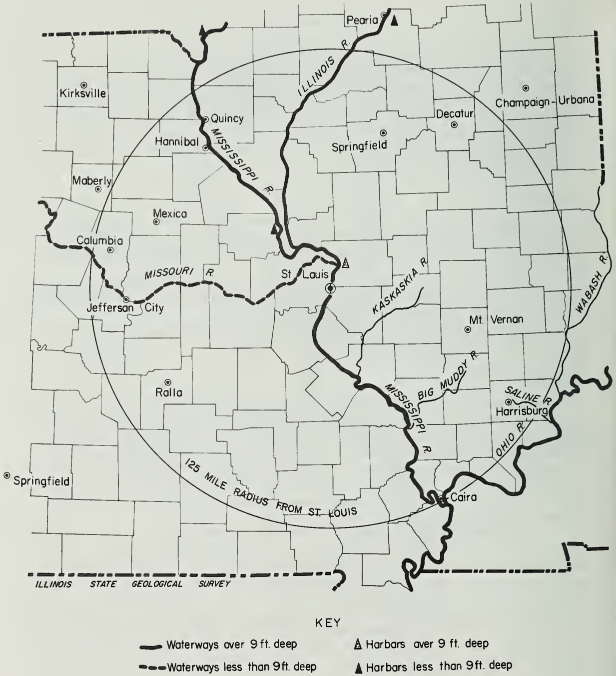


Fig. 14 - Waterway system

Highways

Thousands of miles of federal, state, county, and township roads cross the area. Truck haulage moves large quantities of minerals, especially from the small-sized mining operations. Because of their bulk and their relative abundance and low unit value, items such as crushed stone and sand and gravel usually are moved only short distances. In Illinois, for example, more than 90 percent of the crushed stone and 75 percent of the sand and gravel move by truck. On the other hand, only 12.5 percent of the coal moves by truck; 82 percent is shipped by rail.

Pipelines

Pipelines provide a cheap and effective means of transporting liquid and gaseous mineral fuels. The advantage is demonstrated by the fact that, of the 2.5 billion barrels of domestic crude oil received by U. S. refineries in 1959, 83.7 percent arrived via pipeline, 14.7 percent via water, and only 1.6 percent by truck and rail.

New Concepts in Mineral Transportation

Because of the weight and bulk of many minerals as compared to their unit value, transportation is an important factor in their delivered cost. Where considerable distances are involved, transportation costs may exceed the cost of the materials themselves.

Vigorous efforts have been make in recent years to find ways of cutting transportation costs of minerals. Coal has been active in these attempts because of its keen competition with other fuels. Coal may offer the best opportunity for the application of new procedures because large quantities often move from a single producing mine to a single consumer.

Among the new unconventional methods reciving study and being applied are the unitized train and pipeline transportation of coal and the extra-high-voltage transmission of electric power.

Unitized Train.—The proposed unitized train will consist of cars and locomotives permanently or semi-permanently coupled together. Trains of up to 250 cars capable of carrying as much as 25,000 tons have been proposed. The unit will shuttle back and forth from mine to consumer without need for the costly and time-consuming switching and assembly operations normally required. The shuttle train principle is being applied successfully on a smaller scale in a number of locations and recent announcements have indicated that at least two shuttle trains will be put into service in Pennsylvania within the near future (Wall Street Journal, April 6, 1962). Considerable savings are anticipated.

Coal Pipeline.—A second development in coal transportation is the coal pipeline. A pipeline has been in operation from Cadiz, Ohio, to Cleveland since 1957, using a 50-50 mixture (slurry) of water and finely ground coal. Research has recently shown that this can be increased to 70 percent coal and still maintain satisfactory operations. A burner has been developed to burn the slurry directly, eliminating the necessity of drying the coal. Pipelines appear especially suitable for serving large utility markets.

Extra-High-Voltage Transmission.—A third possibility that is receiving much attention involves not the movement of the coal but the extra-high-voltage transmission of electric power over greater distances than is customary at present. If proper procedures and long distance facilities can be developed to reduce transmission by using extra-high-voltages, the trend toward building power plants at the coal mines will be accelerated. By placing the plants at the mine mouth, all fuel transportation will be eliminated and the coal will, in effect, be sent by wire.

Progress in any of the above three fields will succeed in reducing the cost of industrial energy to a point even lower than at present.

PART IV. CONCLUSION

There are few areas that can offer a complex of mineral resources—energy fuels, coking coal, iron ore, fluorspar, base metals, industrial, and construction materials—that will match that of Illinois and Missouri. These, combined with well developed but still expanding networks of transportation facilities and power and fuel distribution lines, should provide the region with a sound basis for strong growth and industrial development in the years to come.

The primary function of mineral resources is that of providing materials to sustain the industrial activity of the region and the material standard of living of its people. The minerals industry's role extends far beyond that of a mere supplier of goods and energy. Its other economic contributions are both numerous and extremely important.

One contribution of the minerals industry to the economy is the direct employment it provides. In 1958, within the counties studied, more than 30,000 employees were engaged directly in the production of minerals. The payroll drawn by these people during that year exceeded 150 million dollars, and the value of mineral output was over 665 million dollars.

Rarely are mineral products consumed at their point of origin. Frequently, they must be transported over long distances for processing, fabrication, or other use. Most of the material shipped by barge, a large portion of that moved by rail, and nearly all that transported by pipeline is of mineral origin. These products, therefore, contribute significantly both to freight revenues and to employment of those directly involved in the handling and movement of goods and the maintenance of transport facilities.

In the same manner, the firms and employees engaged in the production and transmission of electric power generated from mineral fuels are directly dependent upon the minerals industry.

The processing of minerals constitutes another activity directly dependent upon the availability of resources. During 1958, within the St. Louis Standard Metropolitan Area, 38,500 workers received 215 million dollars for their work in minerals processing operations (tables 17 and 18). Such operations included the production of refined products from petroleum and coal, the manufacture of cement, ceramics goods, and glass from stone, clay, and sand, and the primary metals industries.

The fabrication of metals into machinery, equipment, and other items employed another 92,000 workers during the year with earnings of 233 million dollars.

In total, the processing of minerals and metals from raw state to finished product makes up more than half the manufacturing employment and payroll in the Standard Metropolitan Area of St. Louis.

TABLE 17 - MANUFACTURING EMPLOYMENT IN THE ST. LOUIS STANDARD METROPOLITAN AREA IN 1958

Manufacturing categories	Employees	
	Number	Percent
Petroleum and coal products	6,871	
Stone, clay and glass products	10,150	15.80
Primary metal industries	21,460	
Fabricated metal products	17,880	7.30
Machinery except electric and construction	16,200	
Electrical machinery	16,311	30.30
Transportation equipment	41,374	
Sub total	130,246	53.40
Other manufacturing categories	113,327	46.60
All categories	243,573	100.00

Source: United States Bureau of the Census

TABLE 18 - MANUFACTURING PAYROLL IN THE ST. LOUIS STANDARD METROPOLITAN AREA IN 1958

Manufacturing categories	Payroll	
	Dollars (1,000)	Percent
Petroleum and coal products	$ 42,654	
Stone, clay and glass products	52,094	17.30
Primary metal industries	120,186	
Fabricated metal products	92,410	7.40
Machinery except electric and construction	85,391	
Electrical machinery	79,623	32.00
Transportation equipment	232,829	
Subtotal	705,187	56.70
Other manufacturing categories	537,282	43.30
All manufacturing categories	$1,242,469	100.00

Source: United States Bureau of the Census

A further point of major significance is related not to the dependence of economic activity upon the availability of minerals for direct use as materials, but to the direct and indirect interdependence of minerals upon each other.

The production of steel requires not only iron ore, but also coke, limestone, and fluorspar. The iron and steel industry also is directly and indirectly a large consumer of fuels. In addition to the fuel consumed directly within the plants, the iron and steel industry uses 10 percent of the total electrical power consumed by all manufacturing industries within the United States.

Although the principal materials used in the manufacture of aluminum are bauxite and cryolite, the aluminum industry is one of the greatest power consumers of the nation and thus, indirectly, of mineral fuels. Average power consumption in primary aluminum production is approximately 1 1/2 million kilowatt hours per worker per year. This means that for every eight workers employed in primary aluminum production, enough electric power is used to keep one miner, on the average, busy mining coal to generate that power. Thus, if a new 2,400 man plant were to come into the area south of East St. Louis, as has been reported, full time work might be anticipated also for 300 miners to produce the coal requisite for power generation.

Almost every area in the United States is clamoring for new industry and new development. Illinois and Missouri possess a combination of resources that can scarcely be matched.

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